Claims

[c1] 1.An europium-activated oxide phosphor comprising a compound having a formula of $(Gd_{1-x-y}Y_xLa_y)(Al_{1-z-v}Ga_zIn_v)O_3:Eu^{3+}$; wherein $0 \leq x, y, x, v \leq 1$, $0 \leq x+y \leq 1$, and $0 \leq z+v \leq 1$; said phosphor being capable of absorbing UV radiation and emitting in a visible wavelength range from about 580 nm to about 770 nm; wherein europium is present in an amount from about 0.0005 to about 20 mole percent, and said phosphor being capable of absorbing at least 80 percent of exciting UV radiation at wavelength of about 254 nm.

[c2] 2.The phosphor of claim 1, wherein europium is present in an amount from about 0.0005 to about 10 mole percent.

[c3] 3. The phosphor of claim 1, wherein europium is present in an amount from about 0.001 to about 5 mole percent.

[c4] 4.The phosphor of claim 1, wherein said phosphor has a formula of $GdAlO_3:Eu^{3+}$.

[c5] 5.The phosphor of claim 1, wherein said phosphor has a formula of $YAlO_3:Eu^{3+}$.

[c6] 6.The phosphor of claim 1, wherein said phosphor has a formula of $LaAlO_3:Eu^{3+}$.

[c7] 7.A phosphor blend comprising a trivalent europium-activated oxide phosphor comprising a compound having a formula of $(Gd_{1-x-y}Y_xLa_y)(Al_{1-z-v}Ga_zIn_v)O_3:Eu^{3+}$; wherein $0 \leq x, y, x, v \leq 1$, $0 \leq x+y \leq 1$, and $0 \leq z+v \leq 1$; said phosphor blend absorbing EM radiation substantially in a wavelength range from about 250 nm to about 400 nm.

[c8] 8.The phosphor blend of claim 7, wherein said phosphor blend further comprising at least one other phosphor substantially emits in a visible wavelength range other than a range from about 580 nm to about 770 nm.

[c9]

9.The phosphor blend of claim 7, wherein said phosphor blend emits white light

upon being excited by UV EM radiation.

[c10] 10.The phosphor blend of claim 7, wherein said white light has color coordinates substantially on a black body locus of a CIE chromaticity diagram.

[c11] 11.A light source comprising:

(a)a source of gas discharge; and

(b)a phosphor blend comprising a trivalent europium-activated oxide phosphor comprising a compound having a formula of $(Gd_{1-x-y}Y_xLa_y)(Al_{1-z-v}Ga_zIn_v)O_3:Eu^{3+}$; wherein $0 \leq x, y, x, v \leq 1$, $0 \leq x+y \leq 1$, and $0 \leq z+v \leq 1$; said phosphor blend absorbing EM radiation from said gas discharge in a wavelength range from about 250 nm to about 400 nm and emitting light in a visible range.

[c12] 12.The light source of claim 11, wherein said europium-activated oxide phosphor is $GdAlO_3:Eu^{3+}$.

[c13] 13.The light source of claim 11, wherein said europium-activated oxide phosphor is $YAlO_3:Eu^{3+}$.

[c14] 14.The light source of claim 11, wherein said europium-activated oxide phosphor is $LaAlO_3:Eu^{3+}$.

[c15] 15.The light source of claim 11, wherein said phosphor blend further comprises at least an additional phosphor selected from one of the groups consisting of:

$BaMgAl_{10}O_{17}:Eu^{2+}$, $Sr_5(PO_4)_3Cl:Eu^{2+}$, $Sr_4Al_{14}O_{25}:Eu^{2+}$, $Sr_3(PO_4)_5Cl:Eu^{2+}$, $Sr_2Al_6O_{11}:Eu^{2+}$, and mixtures thereof;

$CeMgAl_{11}O_{17}:Tb^{3+}$, $(Ce,La)PO_4:Tb^{3+}$, $(Ce,Gd)MgB_5O_{10}:Tb^{3+}$, $LaPO_4:Ce^{3+},Tb^{3+}$; and mixtures thereof; and

$Y_2O_3:Eu^{3+}$, $YBO_3:Eu^{3+}$, $3.5MgO \bullet 0.5MgF_2 \bullet GeO_2:Mn^{4+}$, and mixtures thereof.

[c16] 16.A method for making an europium-activated rare-earth and Group-IIIB oxide phosphor, said method comprising:

(a)providing a mixture of:

(1)at least a compound of at least a rare-earth metal selected from the group

consisting of gadolinium, yttrium, lanthanum, and combinations thereof;
(2)at least a compound of europium; and
(3)at least a compound of at least a Group-IIIB metal selected from the group consisting of aluminum, gallium, indium, and combinations thereof; wherein at least one compound of said at least a Group-IIIB metal is a halide; and
(b)firing said mixture in an oxygen-containing atmosphere at a temperature and for a time sufficient to convert said mixture into said trivalent europium-activated gadolinium aluminum oxide phosphor.

[c17] 17.The method of claim 16, wherein said at least a compound of said at least a rare-earth metal is an oxygen-containing compound.

[c18] 18.The method of claim 16, wherein said at least a compound of said europium is an oxygen-containing compound.

[c19] 19.The method of claim 16, wherein said at least a compound of said at least a Group-IIIB metal is an oxygen-containing compound.

[c20] 20.The method of claim 16, wherein said halide is fluoride.

[c21] 21.The method of claim 16, wherein said halide provides from about 1 to about 25 atom percent of a total amount of said at least a Group-IIIB metal.

[c22] 22.A method for making a trivalent europium-activated rare-earth and Group-IIIB oxide phosphor, said method comprising:
(a)providing a first solution which comprises:
(1)at least a compound of at least a rare-earth metal selected from the group consisting of gadolinium, yttrium, lanthanum, and combinations thereof;
(2)at least a compound of europium; and
(3)at least a compound of at least a Group-IIIB metal selected from the group consisting of aluminum, gallium, indium, and combinations thereof; wherein at least one of said at least a compound of said at least a Group-IIIB metal is a halide;
(b)providing a second solution comprising a material selected from the group consisting of ammonium hydroxide, ammonium carbonate, ammonium oxalate, methanolamine, ethanolamine, propanolamine, dimethanolamine,

diethanolamine, dipropanolamine, trimethanolamine, triethanolamine, tripropanolamine, and mixtures thereof;

(c)combining said first solution and second solution to produce a precipitate comprising said at least a rare-earth metal, said europium, and said at least a Group-IIIB metal; and

(d)firing said precipitate at a temperature for a time sufficient to convert said precipitate to said trivalent europium-activated rare-earth and Group-IIIB oxide phosphor.

[c23] 23.The method of claim 22, wherein said halide provides from about 1 to about 25 atom percent of a total amount of said at least a Group-IIIB metal.

[c24] 24.The method of claim 23, wherein said halide is fluoride.

[c25] 25.The method of claim 22, wherein said second solution comprises ammonium hydroxide.

[c26] 26.The method of claim 22 further comprising the step of heating said precipitate in an oxygen-containing atmosphere before the step of firing to convert said precipitate to a mixture of oxygen-containing compounds of said at least a rare-earth metal, europium, and said at least a Group-IIIB metal.

[c27] 27.The method of claim 26, wherein said step of heating is carried out at a temperature in a range from about 400 ^{0}C to about 900 ^{0}C.

[c28] 28.The method of claim 26 further comprising the step of pulverizing said mixture of oxygen-containing compounds after said step of heating and before said step of firing.

[c29]

29.A method for making a trivalent europium-activated gadolinium aluminum oxide phosphor, said method comprising:

(a)providing a first solution which comprises:

(1)at least a compound of at least a rare-earth metal selected from the group consisting of gadolinium, yttrium, lanthanum, and combinations thereof;

(2)at least a compound of europium; and

(3)at least a compound of at least a Group-IIIB metal selected from the group

consisting of aluminum, gallium, indium, and combinations thereof;

(b)providing a second solution comprising a material selected from the group consisting of ammonium hydroxide, ammonium carbonate, ammonium oxalate, methanolamine, ethanolamine, propanolamine, dimethanolamine, diethanolamine, dipropanolamine, trimethanolamine, triethanolamine, tripropanolamine, and mixtures thereof;

(c)combining said first solution and second solution to produce a precipitate comprising said at least a rare-earth metal, europium, and said at least a Group-IIIB metal;

(d)adding at least a halide of said at least a Group-IIIB metal to said precipitate to form a Group-IIIB halide-containing precipitate; and

(e)firing said Group-IIIB halide-containing precipitate at a temperature for a time sufficient to convert said Group-IIIB halide-containing precipitate to said trivalent europium-activated rare-earth and Group-IIIB oxide phosphor.

[c30] 30.The method of claim 29, wherein said at least a halide is a fluoride.

[c31] 31.The method of claim 29, wherein said at least a halide provides from about 1 to about 25 atom percent of a total amount of said at least a Group-IIIB metal.

[c32] 32.The method of claim 29, wherein said second solution comprises ammonium hydroxide.

[c33] 33.The method of claim 29 further comprising the step of heating said at least a Group-IIIB halide-containing precipitate in an oxygen-containing atmosphere before the step of firing to convert said at least a Group-IIIB halide-containing precipitate to a mixture of oxygen-containing compounds of said at least a rare-earth metal, europium, and said at least a Group-IIIB metal.

[c34] 34.The method of claim 33, wherein said step of heating is carried out at a temperature in a range from about 400 ^{0}C to about 900 ^{0}C.

[c35] 35.The method of claim 34 further comprising the step of pulverizing said mixture of oxygen-containing compounds after said step of heating and before said step of firing.